1.5.2. FUSION OF TWO ILLUMINATION TECHNIQUES AND COMBINATION WITH ONE DATA PROCESSING TECHNIQUE FOR INSPECTION SMALL BOREHOLES

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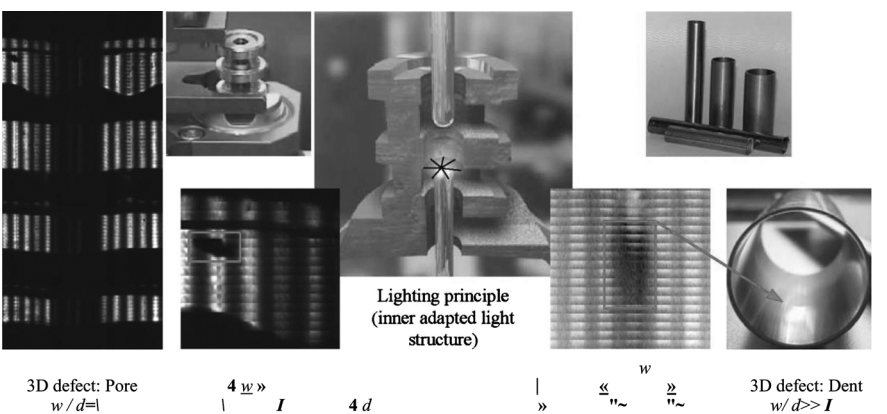
Inspecting small inner surfaces, i.e. of a few millimetre diameters, is a challenging task. Indeed, the necessary recording components, as the optics and the lightings have to be positioned in a small cavity in order to gain adequate images of the inner surfaces to be inspected. Hence, appropriate hardware components and adequate image processing methods have to be developed. Inspection difficulty is all the more difficult, if in addition to the visual enhancement task of defective surface parts, different types of defects have to be detected. Indeed, certain types of defects can only be enhanced with a specific lighting technology, which implies that the number of necessary recordings to reveal all surface defects is equal to the number of defect types. Thus, miniaturized, adequate and multimodal lightings combined with appropriate data processing methods have to be developed.

The optical components group of the Fraunhofer Institute for Integrated Circuits has a long year experience in the development and integration of combined lighting and data processing methods. These researches mainly concern the automatic inspection of reflective inner and outer surfaces. The actual developments show that it is possible to adapt the deflectometry-based lighting for the inspection of small inner surfaces. Furthermore, that appropriate algorithms serves the simultaneous detection of different defect types. The figure shows the adapted deflectometry-based illumination principle, applied to two dif-



Adapted lighting principle (fusion of a diffuse and a structured one) applied to different inner surfaces, where each one depicts different defect types, namely a pore and a dent. These can be characterized by the geometric surface

deformations, i.e. the width to depth ratio of the defect

ferent inner surfaces. The former is characterized by a partially cylindrical geometry with a pore defect to be detected. The latter is a perfect cylinder where a dent defect has to be detected. Both surfaces have a high reflective part. This justifies the use of deflectometric lighting techniques, which are based on the reflection of the light.

Conventional lighting approaches would involve two different techniques to reveal these two different defects, namely a diffuse for the pores, and a structured (e.g. bright or dark field) for the latter. However, the reached results depicted in the figure, demonstrate that it is possible to apply a deflectometry-based technique, to reveal and detect simultaneously different defect types on inner surfaces. The technique is based on the fusion of a diffuse and a structured lighting.

To conclude, it is demonstrated that boreholes with a few millimeter diameters can be inspected so that different defect types can be simultaneously visually enhanced and discriminated. The main parts of these developments were defined for industrial applications successfully integrated in the production lines.